IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicant(s): LEE, Ka-lun

Application No.: Group:

Filed: August 17, 2001 Examiner:

For: ELECTRIC MOTOR

L E T T E R

Assistant Commissioner for Patents
Box Patent Application
Washington, D.C. 20231

August 17, 2001
1928-0121P-SP

Sir:

Under the provisions of 35 USC 119 and 37 CFR 1.55(a), the applicant hereby claims the right of priority based on the following application(s):

Country	Application No.	Filed
United Kingdom	0020418.0	08/19/00
United Kingdom	0023268.6	09/21/00

A certified copy of the above-noted application(s) is(are) attached hereto.

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Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By: Joe McKinney Muncy

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1 of 2

INVESTOR IN PEOPLE

The Patent Office
Concept House
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J1017 U.S. PTO
09/931041
08/17/01

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21AUG00 E562072-3 002696
P01/7700 0.00-0020418.0

The Patent Office
Cardiff Road
Newport
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1. Your reference

MRH.PO4411GB /P274

2. Patent application number
(The Patent Office will fill in this part)

0020418.0

19 AUG 2000

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Johnson Electric S.A.
Rue Fritz-Courvoisier 40
CH-2300 La Chaux-de-Fonds
Switzerland

7964174001

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

Switzerland

4. Title of the invention

ELECTRIC MOTOR

5. Name of your agent *(if you have one)*

A.R. Davies & Co.

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

27 Imperial Square
Cheltenham GL50 1RQ
England

Patents ADP number *(if you know it)*

570001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Number of earlier application	Date of filing *(day / month / year)*

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Claim(s)	1
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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
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Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature A.R. Davies Date

A R Davies & Co 18th August 2000

12. Name and daytime telephone number of person to contact in the United Kingdom

Mr M R Higgins
01242 524520

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DUPLICATE

Electric Motor

This invention relates to electric motors and in particular, to an electric motor incorporating a speed sensor circuit.

The emphasis on designing electric motors, especially miniature permanent magnet electric motors, has been and continues to be to reduce the size or volume of the motor without loss of power output. However, in the past, as components are added to a motor to improve an aspect of the motor, the size of the motor has been increased to accommodate the new component(s). This is particularly evident for speed sensors which are required for servo systems. Speed sensors generally provide a voltage or pulse output whose amplitude or frequency is a function of the velocity of the motor. This signal is used by a servo amplifier to control the motion of the motor. The pulse signals can also be used to determine the position of the motor output or the object being driven by the motor. Typical techniques include adding tacho-generators or frequency generators to the shaft of the motor. These require additions to the motor frame size and thereby increases its bulk.

Techniques involving detecting the current peaks in the motor's electrical input have been tried and while moderately successful, involve sensitive electronics which are affected by noisy environments and unclean commutator switching which often occurs with motor wear rendering the sensor inoperative in a worst case scenario.

Accordingly, there is a need for a speed sensor which is independent of input power and which does not increase the bulk or size of the motor.

This is achieved by the present invention by a sensor coil being formed on an inner face of a stator magnet and located in the air gap between the magnet and the rotor.

Thus, the present invention, in one aspect thereof, provides a permanent magnet direct current motor comprising: a permanent magnet stator including at least one permanent magnet; a rotor including a rotor shaft, an armature core mounted on the shaft and having a plurality of poles, coils wound about the poles forming an armature winding, and a commutator mounted on the shaft adjacent one end of the armature core and connected to lead wires of the coils, the rotor being journaled in bearings and located confronting the stator; and a speed sensor; wherein the speed sensor is a coil of conductive material located in the air gap between the permanent magnet and the armature core.

Preferably, the coil is a single turn coil fixed to an inner face of the magnet facing the armature core.

Preferably, the coil is a single turn coil in the form of a long narrow "U".

Preferably, the terminals of the coil are located on an axial end face of the magnet.

Preferably, the terminals of the coil mate with resiliently deformable fingers or spring biased terminals fixed to the motor end cap.

One preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is an exploded view of a pmdc motor in accordance with the preferred embodiment;

Figure 2 shows a magnet of the motor of Figure 1 supporting a speed sensor coil;

Figure 3 shows a similar magnet supporting a speed sensor coil having a different shape; and

Figure 4 shows a similar magnet supporting a speed sensor coil similar to the coil of Figure 3 in a different location.

Figure 1 illustrates a typical pmdc 10 motor modified to incorporate a speed sensor coil 12 according to the present invention. The motor has a permanent magnet stator having two arcuate ceramic magnets 14. A rotor 16 is located in confronting relationship with the stator and is journaled in bearings 18 fitted to an end cap 20 and a rear housing part 22. The rotor has a shaft 24, armature core 26 and a commutator 28. The armature core 26 is a stack of laminations forming a plurality of salient poles about which coils are wound forming an armature winding 30. The coils are terminated on the commutator 28.

The end cap 20 also supports brushes 32 which make sliding contact with the commutator 28 to electrically connect the armature winding 30 to a source of electric power via motor terminals 34. The end cap also supports two spring contacts 36. The spring contacts are resiliently deformable conductive strips which are connected to sensor terminals 40 on the end cap.

One of the two magnets 14 has a conductive coil 12 formed on its radially inner surface which faces the armature core 26 across an air gap such that the coil 12 is in the air gap between the magnet 14 and the armature core. The coil 12 has a conductive U-shaped path forming a single turn. The thus shaped single turn coil starts and finishes at terminal pads 38 on an axial face of the magnet adjacent the end cap. The two spring contacts 36 are arranged to contact the terminal pads 38 to allow the signal to be transferred from the coil 12 to external circuitry via the sensor terminals 40 on the end cap 20. The use of spring contacts greatly simplifies construction compared with soldering lead wires directly to the coil on the magnet.

The coil 12, being a single turn coil, is easy to apply without providing insulation between the turns. As such, the coil can be a conductive film, conductive foil, conductive tape or wire. In the embodiments described, the coil 12 is formed using conductive ink applied by pad printing onto the surface of the magnet. Alternatively, the ink could be applied by screen printing or painting but this is more difficult due to the surface of the magnet being curved. The magnet surface is treated with a sealing material to prevent the magnet from rusting. As this material is insulating, no further insulating process is required.

Although good results are obtainable using this method as generally described, cleaner signals are produced using a narrow U-shaped single turn coil 12 centered circumferentially across the face of the magnet 14 as shown in Figure 3. Alternatively, for a single direction motor, the coil 12 could be located adjacent one edge of the magnet 14 as shown in Figure 4, for example.

With the coil 12 located between the magnet and the armature core 26, the magnetic flux passing through the coil varies as the rotor turns from a maximum when a pole is adjacent the coil to a minimum when a slot between the poles is adjacent the coil. The variation in the magnetic flux creates a voltage pulse in the coil and thus, as the rotor rotates, the sensor coil produces a pulse signal. By measuring the time between pulses, the speed of the motor can be determined. This information can then be used in a motor controller for controlling the speed of the motor.

While one embodiment has been described in detail, various modifications will be apparent to the skilled addressee without departing from the spirit of the invention and it is intended that all such variations be covered by the invention as defined by the appended claims.

Claims:

1. A permanent magnet direct current motor comprising:

a permanent magnet stator including at least one permanent magnet;

a rotor including a rotor shaft, an armature core mounted on the shaft and having a plurality of poles, coils wound about the poles forming an armature winding, and a commutator mounted on the shaft adjacent one end of the armature core and connected to lead wires of the coils, the rotor being journaled in bearings and located confronting the stator; and

a speed sensor;

wherein the speed sensor is a coil of conductive material located in the air gap between the permanent magnet and the armature core.

2. A motor according to Claim 1 wherein, the coil is a single turn coil fixed to an surface of the magnet facing the armature core.

3. A motor according to Claim 2 wherein, the coil is a single turn coil in the form of a long narrow "U".

4. A motor according to any one of the preceding claims wherein, terminals of the coil are located on an axial end surface of the magnet.

5. A motor according to any one of the preceding claims wherein, terminals of the coil mate with resiliently deformable fingers extending from the motor end cap.

6. A motor according to any one of Claims 1 to 4 wherein, terminals of the coil mate with spring biased terminals fixed to the motor end cap.

7. A motor according to any one of the preceding claims wherein the coil is laterally centred on the surface of the magnet.

8. A motor according to any one of claims 1 to 6 wherein, the coil is located on the surface of the magnet in close proximity to a lateral edge of the magnet.

9. A permanent magnet direct current motor substantially as hereinbefore described with reference to the accompanying drawings.

Abstract

A permanent magnet direct current motor 10 has a permanent magnet stator with at least one permanent magnet 14. The magnet 14 faces poles of an armature core 26 across a small air gap. A speed sensor 12 is located in the air gap for detecting rotation of the armature core. The speed sensor 12 is a single turn coil fixed to a surface of the magnet 14 facing the armature core. Terminals 38 of the coil are located on an axial end surface of the magnet and mate with resiliently deformable fingers or spring biased terminals 36 fixed to the motor end cap 20.

Figure 1

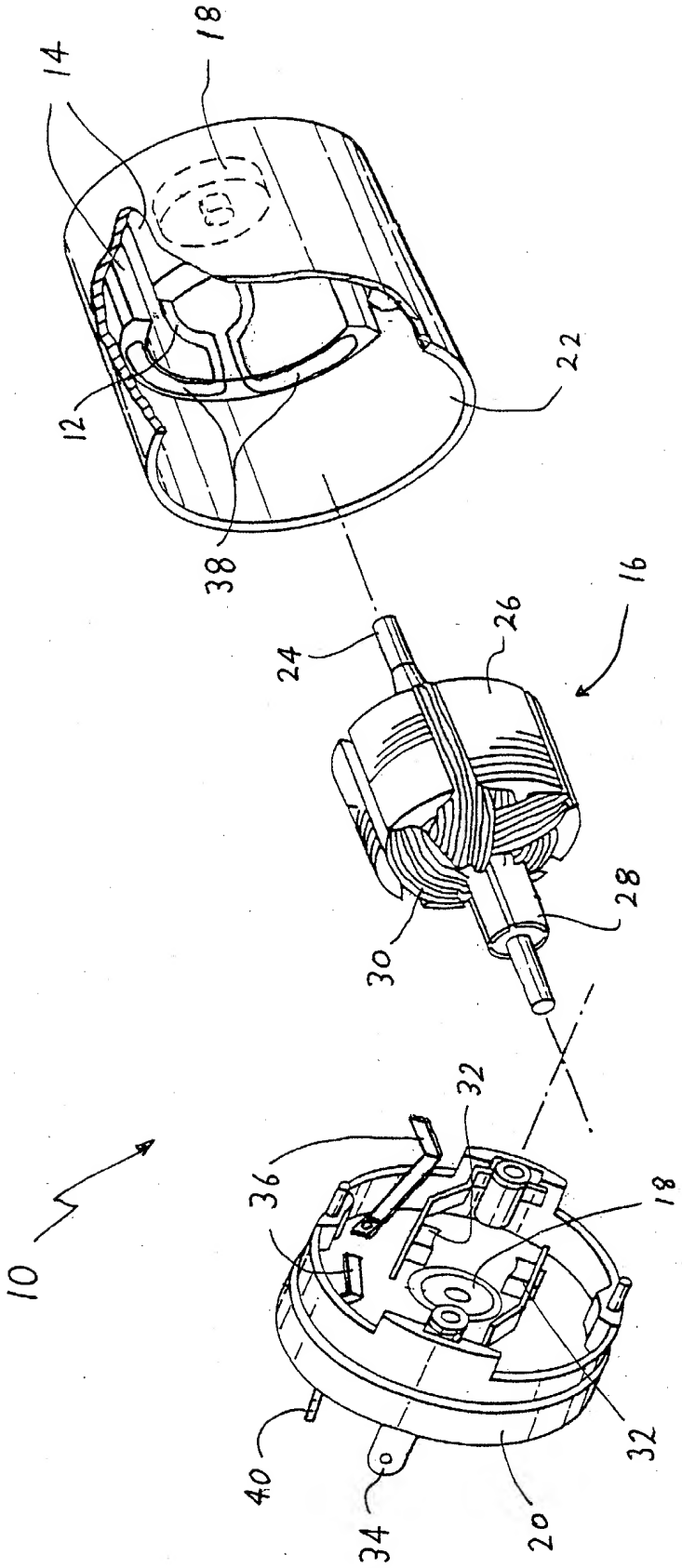

FIG. 1

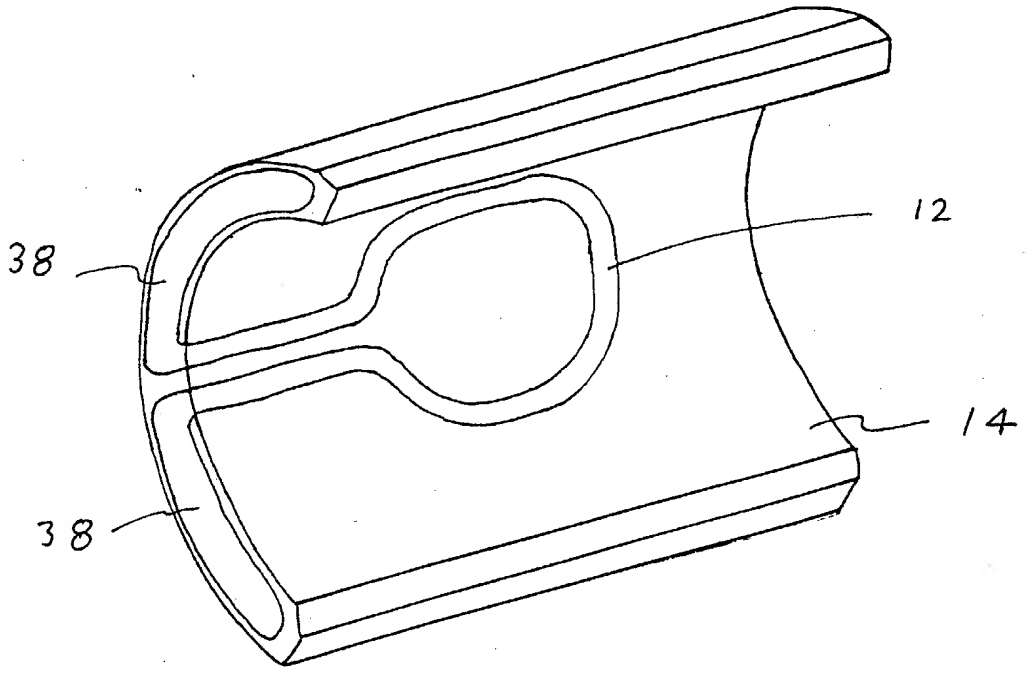

FIG. 2

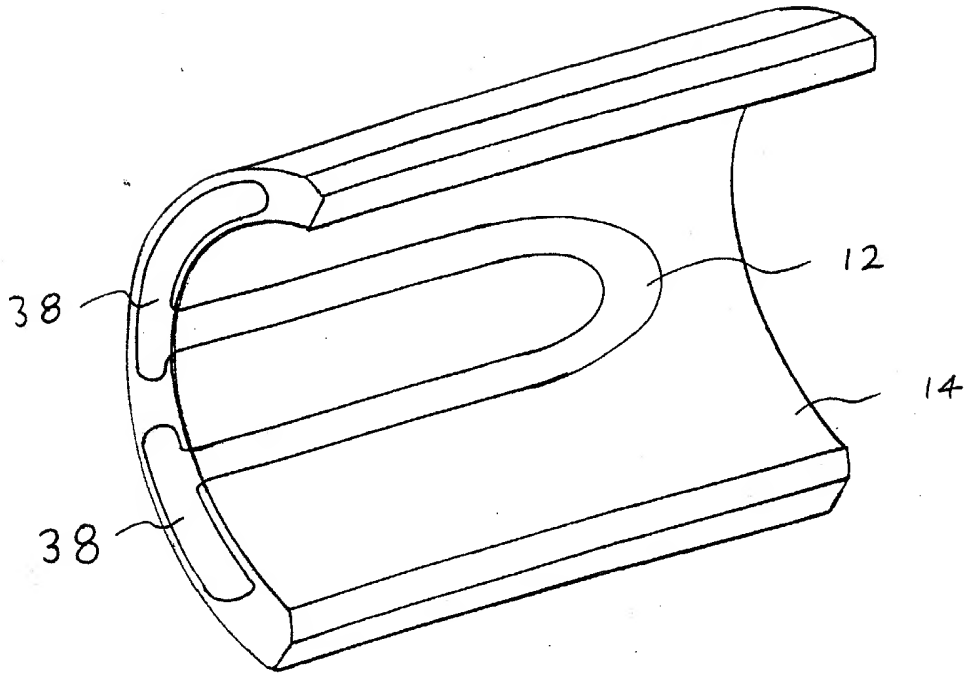

FIG. 3

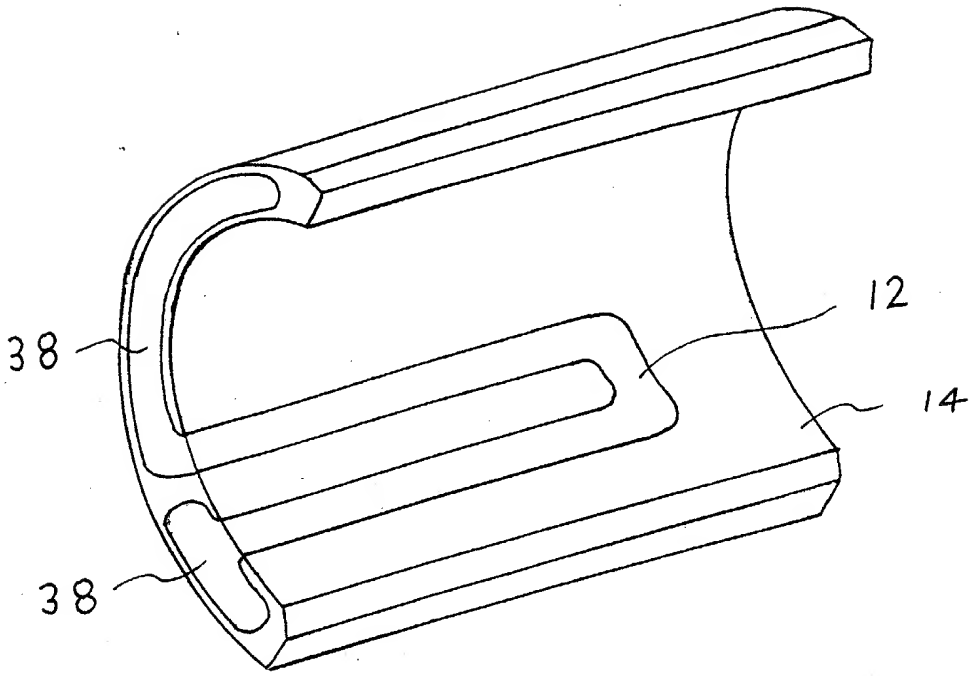

FIG. 4